BRAKE DISK FOR VEHICLES

TECHNICAL FIELD

The present invention relates generally to vehicular transportation and more particularly to brake systems using brake disk devices.

BACKGROUND ART

Any moving vehicle, or any item with transrotary movement, needs some sort of mechanism for absorbing energy, in order to reduce the speed of rotation. One of the most common and most effective methods for braking on vehicles in the disk brake system. This style uses a disk which is coupled to and rotates with the wheel and brake pads which are fixed in position and frictionally engage the sides of the disk when activated. This style of brake mechanism is used on many types of vehicles, but is particularly popular on motorcycles.

The earliest and simplest forms of disk brakes utilize simple flat disks having smooth surfaces and regular shapes. However, as performance requirements became more rigorous various modifications have been introduced. Improvements have been particularly aimed at improving the cooling of the disk material in order to maintain better friction for longer braking periods and to enhance the lifetimes of pads and disks. In addition, modifications have been

made to reduce the weight of the disks, particularly for performance cycles, while maintaining high strength and integrity.

Various disk structures have been utilized, including those with ventilation holes in the disk surface and irregular edges. One of the more popular innovations was introduced by the present inventor in 1998 and involves having the disk rim formed in an undulating pattern with the radial thickness of the disk being less than that of the brake pads, so that only a portion of the pad contacts the disk at a time. Disks of this variety are marketed under the WAVE trademark by Braking Italia and its affiliates.

Significant challenges in braking systems and disk brakes in particular deal with overheating and loss of friction, since the energy absorption associated with braking generates a significant amount of heat energy. Dealing with dissipation and thermal absorption remains a matter for concern and improvement in the industry.

Continuing demand for improved structures persists, so that a need is maintained for disk configurations which provide improved braking characteristics, as well as optimized weight and strength, combined with excellent cooling characteristics.

DISCLOSURE OF INVENTION

Accordingly, it is an object of the present invention to provide a new and improved brake disc for vehicles, particularly motorcycles, which provides better heat dissipation characteristics than the prior available versions.

Another object of the invention is to provide a brake disk which increases effective friction to facilitate quicker braking action.

Yet another object of the invention is to provide a brake disk which may be utilized on a variety of vehicles.

A further object of the invention is to provide a brake disk which is adaptable to mounting on a very wide variety of systems and for use with a wide variety of pad structures.

Briefly, one preferred embodiment of the present invention is a brake disk adapted for installation on the hub of a wheel of a vehicle. The preferred brake disk is especially adapted for use on motorcycles and motor-driven cycles. The brake disk is adapted to mate with and be installed on a variety of hubs and wheels and to mate with varying types of conventional brake calipers and pads.

The preferred brake disk has an irregular shape, both radially and laterally, with alternating segments providing varying surfaces to contact (or be separated from) the brake pads. The disk is circumferentially arrayed about a central axis which corresponds with the hub axle when the disk is mounted on a vehicle. The

disk also may be considered to have a disk plane which will be perpendicular to the central axis and intersect the disk material.

The disk has an outer rim and an inner rim, with the inner rim including, at variously spaced locations, bolt notches for facilitating attachment to the hub. The disk also has an obverse face (side) and a reverse face with the obverse side facing away from the wheel. The thickness of the disk is such that neither face intersects the disk plane at any point. The preferred disk is effectively laterally symmetrical, at least to the extent that either face may be the obverse or the reverse, depending on how it is mounted on the hub. However, the disk is definitely not locally symmetrical about the disk plane.

Each face of the disk includes alternating segments in the form of protruding segments and indented segments which extend varying axial distances from the disk plane. The protruding segments extend further axially so that they will abut against the brake pads when activated, while the indented segments extend to a lesser degree such that no contact with the brake pads ever occurs (barring excess wear). The protruding segments are circumferentially wider than the indented segments such that a greater portion of the disk contacts the brake pads when the calipers are activated. The various segments are aligned such that the indented segments on the obverse are opposite protruding segments on the reverse side, and the indented segments on the reverse are circumferentially opposite protruding

segments on the obverse, so that consistent material strength is maintained throughout.

An advantage of the present invention is that the alternating protruding and indented segments provide for improved heat dissipation and better cooling than continuous surface constructions.

Another advantage of the present invention is that the irregularly shaped protruding segments balance and optimize wear on the brake pads, thus extending the life thereof.

A further advantage of the present invention is that the indented segments provide that portions of the brake pads are not in frictional contact with the brake disk during braking, thus permitting cooling of the pads as well as the disk.

Another advantage of the present invention is that the alternating protruding and indented segments facilitate rapid changes of the specific pressure applied by the pad on the disk, thus providing better initial grip than other disk designs.

Yet another advantage of the invention is that the variegated surface facilitates beading of the brake pad surface during use, thus helping to prevent material crystallization and extending pad life.

Still another advantage of the invention is that there are no holes or apertures extending all the way through the disk, thus minimizing the potential for capturing

impediments, such as twigs or other debris which might interfere with the operation of the brake systems.

A still further advantage of the present invention is that the irregular outside rim surface and, to a lesser degree, the irregular inside rim surface, provide a greater surface area and increase heat dissipation into the environment, resulting in improved cooling.

Yet another advantage of the invention is that the indented segments cause the overall disk to be lighter, resulting in material savings in manufacturing and reduction of overall weight on the vehicle in usage.

These and other objects and advantages of the present invention will become clear to those skilled in the art in view of the description of the best presently known modes of carrying out the invention and the industrial applicability of the preferred embodiments as described herein and as illustrated in the several figures of the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The purposes and advantages of the present invention will be apparent from the following detailed description in conjunction with the appended drawings in which:

Fig. 1 is a side elevational view illustrating a brake disk according to the present invention as installed on the hub of a vehicle;

Fig. 2 is a perspective view of a preferred brake disk, shown standing alone;

Fig. 3 is a front plan view of the disk of Fig. 2;

Fig. 4 is a cross sectional view, taken along line 3-3 of Fig. 3;

Fig. 5 is plan view of a first alternate embodiment of the invention;

Fig. 6 is a plan view of a second alternate embodiment of the invention;

Fig. 7 is a plan view of a third alternate embodiment of the invention; and

Fig. 8 is a front plan view of a fourth alternate embodiment of the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

A preferred embodiment of the present invention is a brake disk device adapted for use on a vehicle, particularly with motorcycles, motor driven cycles and bicycles having disk type brakes. A preferred embodiment of the invention is illustrated in the several figures of the drawing and is identified by the general reference character **10**.

A preferred brake disk **10** is illustrated in Fig. 1 as being installed on a vehicle **12** (partially shown). Other views of the preferred embodiment **10** are illustrated in Figs. 2, 3 and 4 of the drawings, and the present description refers to all of these figures. The vehicle **12** will typically be a motorcycle, although other vehicles and transrotary mechanisms upon which disk brakes are utilized could also benefit from the invention. The perspective view of Fig. 1 shows the disk **10** mounted on a hub **14** of an axle **16** of a wheel **18**. The remainder of a conventional disk brake mechanism, including calipers **20** including brake pads **22**, is illustrated in conjunction with the inventive disk **10**. These mechanisms are more clearly illustrated in Fig. 3. It is understood that the brake mechanism, other than the disk **10**, is conventional and does not form a part of the invention.

The disk **10** is arrayed about a central axis **24** (see Figs. 2 and 3) which is passes through the axle **16** when installed. Although the disk **10** cannot be said to

be radially symmetrical about the central axis **24**, it is generally so, with the material of the disk **10** being in the form of a flat ring with a hollow center. The disk itself is arrayed about a disk plane **26** (see Figs. 2 and 4) which perpendicularly intersects the central axis **24** and passes radially through the material of the disk **10**.

The disk **10** includes an irregular outer rim **28** and an irregular inner rim **30**. The inner rim **30** includes a plurality of bolt notches **32** which receive bolts **34** and facilitate mounting on the hub **14**. Both the outer rim **28** and the inner rim **30** have irregular edge surfaces, adapted to increase surface are over regular surfaces. The present embodiment shows alternating curved edge portions **36** and angled edge portions **38**. The increased surface area on the rims improves heat dissipation into the environment (air) during and after braking, thus improving cooling and improving the lifetime of both the disk and the brake pad.

The disk **10** may be seen as having an obverse side **40** and a reverse side **42** (see Figs. 2 and 4), opposing each other about the disk plane **26**. The designation of obverse and reverse is somewhat arbitrary and is determined by the orientation in which the disk **10** is mounted on the hub **14**, at least in the embodiment shown in the first four figures. The obverse side **40** and the reverse side **42** are functionally symmetrical in that the same pattern of shapes appears on each. However, the pattern is rotated a few degrees.

A principle characteristic of the invention is that the surfaces of the disk **10** include alternating protruding segments **44** and indented segments **46**. These alternating segment provide a varying degree of engagement with the brake pads **22** and facilitate the effective braking action and cooling properties. The indented segments **46** on one side of the disk surface are always opposite protruding segments **44** on the opposing face, although the converse is not the case.

The present embodiment **10** includes two forms of protruding segments **44**. Because of their superficial resemblance to the shape of US states, the two types of segments are referred to herein as "Ohio" segments **48** and "Indiana" segments **50** (see, especially, Fig. 3). The Indiana segments **50** extend further on the inner rim and terminate in the bolt notches **32**.

Each protruding segment **44** has a leading edge **52** and a trailing edge **54**. These designations refer to the interface with the brake pads **22** (see Figs. 1 and 3) and will vary depending on the direction of travel of the vehicle **12** and the orientation of the disk **10** on the hub **14**. The leading edges **52** will provide increased "gripping" with the surface of the brake pad **22** and facilitate quicker deceleration of the vehicle **12**. The leading edge **52** and trailing edge **54** portions also provide increased material surface to aid heat dissipation.

The indented segments **46** define the zone intermediate the adjacent trailing edge **54** of one protruding segment and the leading edge **52** of the next protruding

segment **44**. When the a brake pad **22** is situated opposite an indented segment **46** it will not be in physical contact with the disk **10** and will be subject to air cooling and heat dissipation. In the embodiment of Figs. 2 through 4, each indented segment is open at its ends (at the outer rim **28** and the inner rim **30**) which facilitates lateral air flow therethrough and aids the cooling process. As shown in the alternate embodiments illustrated in Figs. 1 and 5 through 8, the leading edges **52** and trailing edges **54** are not always aligned so that they are radially aligned with the brake pads **22**. It has been found that angles of between 0°and 45° are acceptable for the angle of incidence on such, depending on the type of usage.

The brake pad engaging surfaces of the obverse side **40** and the reverse side **42** are provided with alternating protruding segments **44** and indented segments **46**. The indented segments **46** are circumferentially narrower than the protruding segments **44**. As is particularly apparent in the cross sectional view of Fig. 4, the pattern of segments is rotated on opposing sides of the disk **10** so that each indented segment **46** is axially opposite a protruding segment **44**. This maintains a minimum material thickness at all portions of the disk, including minimal thickness portions **56**, so that the strength of the disk material is not compromised by the indentations. It is noted that some portions of the disk have a greater material thickness, at maximum thickness portions **58**, where protruding segments **44** on each side of the disk **10** are radially opposite. It is believed that the best

results are obtained when the indented segments **46** have a circumferential width of between 10% and 40% of the width of the protruding segments **44**. This means that a greater amount of contact than non-contact with the brake pad is always maintained during braking.

Fig. 5 illustrates a first alternate embodiment of the invention which is designated as **60**. This embodiment has protruding segments **44** which are essentially similar to each other and also has leading edges **52** which are essentially radially normal to the brake pads **22** upon incidence. In addition, the bolt notches **32** are replaced by bolt holes for connecting to the hub at a greater distance form the inner rim **30** than in other embodiments. This design is for specialized use on certain types of vehicles.

Fig. 6 illustrates a second alternate embodiment of the invention which is designated as **62**. This embodiment includes irregularly shaped protruding segments **44** and has certain of the indented segments **46** truncating before reaching the inner rim **30**. Further, the leading edges **52** and trailing edges **54** are less regularly shaped than in the preceding embodiments and are angled with respect to the brake pads.

Fig. 7 illustrates a third alternate embodiment of the invention which is designated as **64**. This embodiment includes very irregularly shaped protruding

segments **44** and indented segments **46**. The leading edges **52** and trailing edges **54** are also significantly angled with respect to the brake pads **22**.

Fig. 8 illustrates a fourth alternate embodiment of the invention which is designated as **66**. In this version the protruding segments **44** are somewhat irregular and the indented segments **46** do not all pass through to the inner rim **30**. Further, the leading edges **52** and trailing edges **54**, while regular, are severely angled, and in a different orientation than those of the other embodiments shown.

The preferred brake disks **10, 60**, **62**, **64** and **66** of the present invention are constructed of AISI stainless steel but may also be made of various other materials, such as other types of steel, cast iron, light alloys, titanium, other structural metals and ceramics. The axial thickness of the disk is typically from 1 to 19 mm at the minimal thickness portions **56** and from 2 to 20 mm at the maximal thickness portions **58**. However, this can differ depending on the proposed usage and type of brake mechanism with which the disk **10** is intended to be used. Further the typical diameter of a disk is about 160 to 600 mm, with the axial separation between the outer rim **28** and the inner rim **30** being about 15 to 100 mm. However, all materials and dimensions may vary depending on the use and brake mechanism involved.

The particular arrangement of protruding segments **44** and indented segments **46** may vary depending on the usage desired, with heavy duty uses

having wider indented segments **46** to maximize cooling. Further the shapes of the protruding segments may vary depending on a variety of circumstances. The location of the bolts **34** on the particular hub **14** will define where bolt notches 32 are situated.

Although the preferred disk **10** described above is constructed of AISI stainless steel it is understood that various other materials may be developed or utilized with similar results. Similarly, the precise shapes and dimensions described above are subject to variation, without departing from the sprit and scope of the invention. Further, while various embodiments have been described above, it should be understood that these have been presented by way of example only, and not as limitation. Accordingly, the appended claims are to be interpreted as encompassing the entire spirit and scope of the invention and not merely the embodiments described and depicted herein.

INDUSTRIAL APPLICABILITY

The present invention is adapted for use in conjunction with conventional disk brake systems, particularly those used on motorcycles. The inventive brake disk **10** is especially adapted for use on racing and performance cycles where particular stress is placed on the brake disks. This stress may be both physical and thermal. Therefore, the improved braking characteristics provided by engagement

of the brake pads **22** with the leading edges **52** of protruding segments improve braking in use while the improved cooling and heat dissipation provided by the indented segments **46** keep the brake systems working effectively for longer periods of time during use and extend the lifetime of the components. In addition, the lighter overall construction of the inventive brake disks **10** provide an advantage on performance vehicles where every gram of weight can be important.

For the above reasons, and others, the inventive brake disks according to the present invention are expected to have industrial applicability and commercial utility which are both significant and long lasting.